# Calculating Average Rates of Reaction

*You are required to show work for all calculations.*

1. During the combustion of methane, CH4, shown by the reaction

CH4(g) + O2(g) → CO2(g) + H2O(g)

The concentration of methane was measured at various time intervals and the following results were obtained:

|  |  |
| --- | --- |
| Time  (s) | [CH4]  (mol ⋅ l-1) |
| 10 | 2.40 |
| 20 | 1.20 |
| 30 | 0.80 |
| 40 | 0.60 |

Calculate the average rate of loss of methane during the 10 to 40 second time period.

**Solution:**









Note: the answer is negative because we are calculating the **rate of loss of methane**.

Calculating Reaction Rates using Stoichiometry

**Example:**

In the following decomposition reaction,

 2 N2O5 → 4 NO2 + O2

Oxygen gas is produced at the average rate of 9.1 × 10-4 mol/(L\*s). Over the same period, what is the average rate of the following?

* **The production of nitrogen dioxide**

Rate of production of NO2 = Rate of production of O2 x (molar ratio)

+ = 

= 3.6 × 10-3 

* **The loss of nitrogen pentoxide**

- = 

= -1.8 × 10-3 

**Practice Problems:**

1. Consider the following reaction:

N2(g) + 3 H2(g) → 2 NH3(g)

If the rate of loss of hydrogen gas is 0.03 mol/(L\*s), what is the rate of production of ammonia?

**Solution:**





3. Measurements taken during the reaction CO(g) + NO2(g) → CO2(g) + NO(g)

showed a concentration of carbon monoxide of 0.019 mol/L at 27 min and of 0.013 mol/L at 45 min. Calculate the average rate, in mol/(L\*Min) over this 18 min period, of each of the following:

a) the loss of carbon monoxide, CO

**Solution:**





**Note: The answer is negative because the reactant is being used up**

b) the gain of carbon dioxide, CO2

**Solution:**

molar ratio





**Note: The answer is positive because the product is being produced**

4. In the following reaction the average rate of loss of carbon monoxide, over a set period, is 0.15 mol/(L\*s).

2 CO(g) → CO2(g) + C(s)

What is the average rate of production of carbon dioxide during the same period.

**Solution:**

molar ratio

=



Ethanal vapour undergoes thermal decomposition in the reaction

C2H4O(g) 🡪 CH4(g) + CO(g)

The following data was recorded:

**Table 1:** Concentration of Ethanal During Thermal Decomposition

|  |  |
| --- | --- |
| **[C2H4O] (mol/L)** | **Time (s)** |
| 0.360 | 0 |
| 0.290 | 100 |
| 0.250 | 185 |
| 0.200 | 270 |
| 0.180 | 420 |
| 0.150 | 575 |
| 0.130 | 730 |
| 0.110 | 950 |
| 0.090 | 1250 |
| 0.080 | 1440 |

(a) Use the data in Table 1 to plot a graph of the concentration of ethanal vapour vs. time.

(b) From the graph, determine the average rate of reaction between the times *t=* 0 s and *t* = 420 s. (draw a secant)

(d) Determine the instantaneous rates of decomposition of ethanal when its concentrations are

i. 0.20 mol/L

ii. 0.10 mol/L.

(draw tangents at those points and find the slope of the tangent)

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